carbon in series four of the periodic table, namely, titanium, zirconium, cerium, and thorium. Indeed, "carbonaceous matter" is itself recorded by Prof. Rosenbusch ("Rock-making Minerals," p. 197) as giving rise to pleochroic halos in andalusite. Of course, this might imply nothing more than that chemical similarity leads to similar impurities (*e.g.* thorium), to which the radioactivity may be due. It is not easy to see how such an explanation would fit the case of carbon, but otherwise it would readily account for the fact that halos are not always seen round the minerals mentioned above, and that they may occur round some crystals and yet not round others in the same rock. They are most common, indeed practically constant, round zircon and orthite, but are confined to a few occurrences of the abundant minerals sphene, apatite, and epidote.

Another point which seems to deserve emphasis is the fact that, from a geological point of view, the radioactivity of thorium must surely be a far more potent factor than that of uranium and its derivatives. For there is no mineral which occurs in ordinary rocks which appears to contain uranium in quantities appreciable by chemical methods, whereas, as will be inferred from what has been already said, thorium is of extremely wide distribution.

F. P. MENNELL.

Bulawayo, Rhodesia, October 18.

Magnetic Storms.

IN his letter (NATURE, November 11) Dr. Simpson raises an argument as to the absence of corresponding changes in the electrical potential gradient during magnetic storms which, if admitted, would, I imagine, prove a serious difficulty in the "electron stream" theory of magnetic disturbances. On the assumption that the arriving stream induces an opposite charge which resides at the earth's surface, we can agree with Dr. Simpson's calculation, except that, since there are two current sheets of opposite sign, the potential gradient ought to be half what he finds.

It seems to me most unlikely that the induced charge resides at the earth's surface. The atmosphere is slightly conducting, and it is throughout it that the induced charge distributes itself. It is well known that a very slightly conducting shell will with great rapidity act as a perfect electrostatic screen, but, on the contrary, fails to screen magnetic effects. In his paper (Phil. Trans., A, 1908) on terrestrial magnetism, Dr. Schuster points out that the normal conductivity of air at the earth's surface is about 10^{-24}, while at a height such that the pressure is 1 dyne per sq. cm. the conductivity would be about 10^{-18}. For such a conductivity the time constant of decay would be about 10^{-4} of a second, or, in other words, practically complete electrostatic screening would be established in about one-thousandth part of a second, and correspondingly the slight initial magnetic screening would then cease. We have thus a simple explanation of the absence of direct electrostatic effects at the surface of the earth due to "electron streams" several hundred kilometres above the earth. The earth currents which do accompany magnetic storms are thus referred, not to electrostatic induction, but to change of magnetic induction at the earth's surface.

GEORGE W. WALKER.

Eskdalemuir Magnetic Observatory, November 12.

The Photometric Measurement of the Obliquity Factor of Diffraction.

IN vol. lxxviii. of NATURE (May 21, 1908, p. 55) was published a note on "Secondary Waves of Light," in which I described the diffraction effects produced by an obliquely held rectangular aperture or reflecting surface, and pointed out that the observed distribution of illumination in the pattern was not in accordance with that deduced in the ordinary way. I indicated an explanation of the discrepancy, that it was due to the variation of the obliquity factor of diffraction within the limits of the pattern.

The interest of the observations lay in the fact that such an effect had never been noticed before, and that the observations enabled us actually to trace the variation of the amplitude of vibration from point to point on Huygens's secondary waves. A full description of the effect and a mathematical investigation were published in the *Philosophical Magazine* for January.

The effect observed was that the intensities of illumination in corresponding bands on opposite sides of the central band in the unsymmetrical pattern were unequal. A photometric investigation of this difference in illumination has been carried out. The method was to use revolving sectors to reduce the illumination in one of the two bands to be compared, so as to make them both of equal brightness. The following table illustrates the comparisons made:—

No. of expt.	Ratio of illumination according to ordinary theory	Ratio of illumination actually determined	Ratio of illumination calculated from obliquity
1	1·00	1·66	1·61
2	1·00	1·81	1·98
3	1·00	2·66	2·43
4	1·00	3·25	3·27

The obliquity law demonstrated by these measurements is that, in the hemispherical wavelets emitted by each element of a transmitting aperture or reflecting surface upon which waves are incident at any angle, the amplitude of the light vector is, at any point in the plane of incidence, proportional to the cosine of the angle made by the line joining that point and the element, with the normal to the plane of the element.

C. V. RAMAN.

Post-Box 59, Rangoon.

Mendelian Heredity: A Correction.

I SHOULD be glad of an opportunity of correcting the following errors in my book "Mendel's Principles of Heredity":—

On p. 35, Davenport's result regarding rumplessness in fowls is accidentally inverted. The character, according to him, is recessive, not dominant as stated by me. I have to thank Prof. Arnold Lang for this correction.

The other, and more serious, error is in the description of Fig. 34 of the second impression of the book (p. 231). In giving a tentative scheme for the descent of colour-blindness, I there stated that a male homozygous for colour-blindness could be produced by the mating of two colour-blind parents; but if the scheme is right, it evidently follows that such a male cannot be formed even from that mating.

W. BATESON.

November 12.

The Functions of the Martian Canals.

WITH reference to the recent paper by Dr. Pocklington before the Royal Society, on the functions of the Martian canals, a notice of which appeared in NATURE of November 11 (p. 58), I should like to suggest that these canals may perhaps be used for power-storage purposes. In Mars, possibly, there are seasons of winds or monsoons during which the upper reaches of the canals would be pumped full by innumerable windmills, and the power thus stored utilised during calm seasons, and transmitted electrically for lighting, heating, and general power purposes. For a population which had exhausted all its mineral fuel, which possessed no extensive ocean, and whose soil and climate were unsuitable for the growth of fuel, this would indeed appear to be the only means of obtaining heat and power. The same canals could serve the triple purposes of communication, power, and irrigation.

H. F. HUNT.

7 Officers' Row, Pembroke Dock, Wales,
November 13.

GRAVITY SURVEY.[1]

THE two publications described below afford a remarkable example of the value of an International Bureau worked in the right spirit and used in the right way. The sumptuous institute upon the Telegraphenberg at Potsdam is the home of the

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[1] "Survey of India: Professional Paper, No. 10. The Pendulum Operations in India, 1903–7." By Major G. P. Lenox-Conyngham, R.E.; with an appendix by A. Strahan, F.R.S. Pp. ix+196. (Dehra Dun, 1908.)

"Deutsche Südpolar Expedition, 1901–3." Band i., Geographie; Heft iii., Die Schwerkraftsbestimmungen der Deutschen Südpolar Expedition. By E. von Drygalski und L. Haasemann. Pp. 285–363. (Berlin: Georg Reimer, 1909.) Price 12.80 marks.

Prussian Geodetic Institute and of the Central Bureau of the International Geodetic Association. The same chief directs them both, and a visitor sees no obvious line of demarcation between the two. There is, however, no need to inquire minutely how much is Prussian and how much is international; the resources and experience of both are freely available when advice and cooperation are desired.

The last series of pendulum operations in India had been brought to a close in 1871 with the tragic death of Captain Basevi, who lost his life from exposure while working with the Royal Society pendulums at great altitudes in the Himalayas. When the Government of India resolved to undertake a new and more extensive series, they began by asking the advice of Prof. Helmert, chief of the Central Bureau. He recommended the use of half-second pendulums of the von Sterneck pattern, offered to obtain them from the makers in Vienna who had supplied the Potsdam instruments, and to standardise them at Potsdam. In 1902 Major Burrard and Captain Lenox-Conyngham went to Potsdam to study the use of the pendulums, and Prof. Haasemann, to whom the standardisation had been entrusted, gave up the whole of his time to their instruction. The pendulums were then swung at Kew and at Greenwich, were taken to India, and set to work; and, lastly, it was arranged that Dr. Hecker, of Potsdam, returning from his second "gravity-voyage," should join the Indian pendulum party wherever they might happen to be, and swing his Potsdam pendulums in India, to provide a final control of the circuit Potsdam—Kew—Dehra Dun—Potsdam.

The admirable results of this cooperation are visible on every page of Major Lenox-Conyngham's memoir. He started with an equipment already well tried. He could face the peculiar difficulties of Indian pendulum work with the confidence that he knew all about the ordinary troubles; and, by no means least, he can describe his work in a way which makes it perfectly easy to read in conjunction with German work, for they are written in the same language, though in a different tongue.

It is well known that an exceptional difficulty has embarrassed the survey of India for many years. How much does the enormous mass of the Himalayas and the Tibet plateau to the north, how much does the enormous deficiency of mass in the deep ocean to the south, affect the direction of gravity in India? India was the birthplace of Pratt's celebrated hypothesis of "compensation." The general principle, that an excess of matter above the sea-level is compensated by a deficiency of density below, has been established in the Caucasus and the Tyrol. The fact that gravity is normal, not deficient, over the deep oceans was strongly suggested by Faye when he showed that on solitary islands gravity is in excess by an amount corresponding to the mass of the island above the ocean floor; it has recently been established by Dr. Hecker's elegant application of Mohn's method—the comparison of the mercurial barometer and the boiling-point thermometer at sea.

Only in India has the establishment of the principle of compensation suffered a series of small reverses. Colonel Burrard's series of latitude determinations, published a few years ago, showed that a hidden chain of excessive density runs parallel to the Himalayas to the south, which very much complicates the situation. Major Lenox-Conyngham's pendulums confirm the existence of this chain, and bring to light a new feature—that between it and the Himalayas there is a "ditch" along which gravity is in defect; and, lastly, along the fringe of the mountains their attraction is by no means completely compensated. Five stations in the Himalayas and two in the Baluchistan hills were occupied. "At all these points a deficiency of density is revealed, but in no case does it amount to total compensation. . . . Under all the submontane and mountain stations there appears to be a deficiency which is nearly constant in amount, and is not proportional to the height of the station."

But these interesting results touch only the fringe of the Himalayas, and they are not to be taken as indicating a general failure of complete compensation for the mountain mass as a whole. Before this can be either affirmed or denied it will be necessary to get observations further north; and it is interesting to note that, as Major Lenox-Conyngham points out, it is more important to get well in among the mountains than to climb to excessive altitudes, where the conditions make accurate work almost impossible. Unfortunately, access to Tibet is forbidden to British subjects, including its own scientific servants, by the Indian Government; nor is it easy to disguise a pendulum equipment as a praying-wheel.

The technical details of modern pendulum work are highly interesting, in particular the correction for the flexure of the pendulum support. The present practice is a development of Captain Kater's method of the inverted pendulum initially at rest, which is set swinging by the motion of the stand. In its actual shape it is the invention of Prof. Schumann, of the Prussian Geodetic Institute. An auxiliary pendulum is mounted with its knife-edges parallel to those of one of the set; it has an adjustable weight on the bob by which the times of vibration can be made equal. If one is set swinging, the pull of its knife-edges on the agate plates will rock the stand and set the other swinging; over a considerable range the ratio of the amplitudes of the driven and the driving pendulum increases proportionally to the time, and a simple relation connects this ratio with the virtual increase in the length of the pendulum due to the flexure. It is thus a simple matter to determine the correction for flexure of the stand and pillar at each station, and a pretty illustration of the need of the correction is given by those series which were begun upon a concrete pillar newly cast, and show unmistakably the gradual stiffening of the pillar as the concrete hardened.

The pendulum observations are differential, and it is necessary to choose a base. Kew Observatory was selected, because it had been the base for the earlier Indian series, and the National Physical Laboratory gave valuable assistance in the observation of the base series and a re-determination of the constants of the pendulums for verification. At the suggestion of the Astronomer Royal, Greenwich was chosen as a secondary base. A remarkable feature of the report is the exhaustive appendix by Mr. A. Strahan on the geological strata underlying Kew and Greenwich, and their height above the "Palæozooic floor." With these refinements of observation and discussion the observed differences in the value of *g* at Kew and Greenwich become fairly accordant with the theoretical differences, and warrant the conclusion that "henceforward the pendulum may prove as satisfactory in practice as it has always been attractive in theory."

Dr. Drygalski's Antarctic expedition had the bad fortune to be frozen in just outside the Antarctic circle, and he was unable to reach Antarctic land. His pendulum operations were therefore confined to the island of Saint Vincent in the Cape Verdes, to Kerguelen Island, and to a station on the ice near the winter quarters of the *Gauss*. At the two former gravity was in excess, as is usual on oceanic islands; upon the ice it was nearly normal, which confirms the results of Dr. Hecker's recent determinations of gravity at sea. The observations on the ice were of the heroic order, from difficulty, not with the pendulums, but with the clocks. An ice pillar proved nearly as stable as concrete for the pendulums, but the chronometer stopped at a temperature of −35° C., and the clock was filled with snow in the rather inadequate observing hut. The clock was then removed to the ship and connected with the "flash box" by cable; but the ship heeled over in an Antarctic gale, and again the clock stopped. Finally, after six months' work, it was installed in an ice house, when it went creditably.

The discussion of the observations, largely due to Prof. Haasemann, is full of interest, but the interest lies, unfortunately, in the details of the struggle against adverse circumstances rather than in the wealth of results. It is much to be regretted that Dr. Drygalski's pendulums failed to reach land within the Antarctic circle, for it may be long before so complete an equipment and so accomplished an observer travels again to that sector of the Antarctic.

A. R. H.

A NEW OCEANOGRAPHICAL EXPEDITION.

THE *Times* of November 9 announces the organisation of an important expedition for the investigation of the eastern part of the North Atlantic Ocean, with a possible extension westward to Newfoundland. By an Order in Council, dated October 16, his Majesty the King of Norway has granted permission, subject to certain conditions, for the Norwegian Government steamer *Michael Sars* "to be placed gratuitously at disposal for a scientific expedition in the Atlantic Ocean from the Canary islands to the Færöes, in the spring of 1910, proposed by a British subject, Sir John Murray," and also for "the Fishery Director, Dr. Hjort, Assistant Koefoed, and Mr. Helland-Hansen, as well as the ship's captain and engineer . . . to take part in the expedition while continuing to draw their salaries."

The *Michael Sars* is to sail under the Norwegian flag during the expedition, which is to extend over not more than four months, and Sir John Murray has undertaken to pay all expenses not provided for by the Order in Council.

The chief purpose of the forthcoming expedition, which must necessarily contribute results of first-rate importance to the science of oceanography, is to apply the new instruments and methods of research developed during the last few years, more particularly by the International Council for the Study of the Sea, to the deeper regions of the open ocean. It is believed that the use of large nets and trawls is practicable in deep water, and that, should this prove to be the case, zoological discoveries of great interest and importance will be made. The application of methods of high precision to the determination of the temperature and salinity of sea water has yielded results which have raised considerable doubt in the minds of some investigators as to the validity of the earlier observations made by the *Challenger* and other expeditions, and the cruise of the *Michael Sars* should not only afford much entirely new information, but provide a means of valuing the earlier work. Specially valuable data may be expected from the use of Ekman's new current-meter, which makes it possible for the first time to obtain direct measurements of the currents in the depth.

THE REV. W. H. DALLINGER, F.R.S.

IN the history of "Protozoology"—a department which has advanced of late so rapidly that it has journals, laboratories, and professorial chairs devoted to it—an honoured place, in one of the earlier chapters, must be given to the late Dr. Dallinger, for to him and to his fellow-worker, the late Dr. Drysdale, we owe the first complete record of a complex Protistan life-history, and at the same time a fine example of careful investigation.

William Henry Dallinger was born in 1842 at Devonport. He entered the Wesleyan ministry in 1861, and travelled various circuits, much esteemed as an impressive and weighty preacher. A serious illness is said to have driven him from theology to biology, for in his convalescence he took up the study of open-air natural history, and became fascinated with microscopic work. In 1880 he was appointed principal of the Wesley College, Sheffield, but he resigned this position in 1888 to devote himself more exclusively to scientific work, the Wesleyan Conference allowing him to retain his status and prerogatives as a minister, though without pastoral charge or any other office. Dallinger did much effective work as a lecturer on the staff of the Gilchrist Educational Trust, and his popular lectures on such subjects as "The Infinitely Little," "An Hour with the Microscope," and "Spiders," were models of clear exposition. He had a vivid and careful style, and give his delighted audiences a sound mixture of accurate facts and suggestive ideas. A good instance was the lecture on "The Lowest and Smallest Forms of Life," which he delivered on the occasion of the Montreal meeting of the British Association in 1884. For many years Dr. Dallinger was secretary of the Royal Microscopical Society, and he occupied the presidential chair from 1883 to 1887. He took a great interest in this society and in its valuable journal. It is said that during his presidency he travelled to attend the meetings a distance equal to about half the circumference of the globe, and it was characteristic of his conscientiousness that he usually journeyed back from London to Sheffield by the early mail train so as to be in time for his college duties in the morning.

Dallinger's scientific work began about 1870, and in 1873-6 he published, along with Drysdale, a series of papers on the life-history of monads in the *Monthly Microscopical Journal.* The characteristic feature of the patient labours of the two friends was continuity of observation. By means of a delicate mechanical stage and other devices they were able to keep their eye on one particular specimen of *Bodo saltans,* or whatever the flagellate might be, and follow it from phase to phase. By using a binocular they were able to change places without losing sight of the particular creature the life-cycle of which was being traced. On one occasion Dr. Dallinger kept up continuous observation for nine hours. The result was that some complete life-histories were worked out—spore-formation, growth of spores into flagellates, repeated fission of flagellates, conjugation, encysting, and spore-formation again. This was interesting in itself, it was prophetic of much that has followed in recent years, and it exposed one of the pitfalls in which believers in present-day abiogenesis are apt to come to grief.

In connection with the spontaneous generation question—which has had so many fruitful results—Drysdale and Dallinger made some interesting studies, showing, for instance, that although boiling the water killed monads in an active condition, it did not kill the spores. For the spores, indeed, the fatal temperature is very much higher, up to 268° F.